Quantum Coherence in Solid Hydrogen

K. Hakuta
Department of Applied Physics and Chemistry
University of Electro-Communications, Chofu, Tokyo182-8585, Japan
CREST, Japan Science and Technology Corporation, Chofu, Tokyo182-8585, Japan

Quantum coherence is now attracting many interests in the fields of quantum computing, quantum information storage, quantum communication. As known quite well, the quantum coherence has been a key issue in laser physics in many years, especially in nonlinear optics. Many optical processes using quantum coherence have been proposed and demonstrated so far using atomic/molecular systems in the gas phase. A key reason why atomic/molecular systems have been preferred would be that they have well-defined quantum states with slow dephasing rates. If the physics of quantum coherence has been extended to the solid mediums, it would be very beneficial for implementing quantum computing etc. In this context, many challenges are now in progress from various viewpoints. Among them, the quantum dot would apparently be one of the very promising candidates. In our group, however, we are working in a different way. Our idea is to use *solid hydrogen as a quantum coherence medium.*

Solid hydrogen is the simplest molecular solid consisting of H_2 molecules. Its remarkable feature is that H_2 molecules in the solid can freely rotate and vibrate as in the gas phase, and we can model the system simply as a H_2 system with solid density. In this talk we discuss how the solid hydrogen could offer unique opportunities for manipulating and using quantum coherence. We first discuss on the high-resolution spectroscopy of solid hydrogen and show how good it is as the work medium. Next we discuss on some optical parametric processes using quantum coherence in solid hydrogen, such as arbitrary and efficient sideband generation, slow light propagation in a transparent medium. Finally, we discuss on a possibility to manipulate the quantum coherence of orthohydrogen nuclear spin embedded in parahydrogen matrix.